Anomalous B-field Dependence of Spin-flip Time in High Purity InP\(^1\) XIAYU LNPENG, TODD KARIN, University of Washington, RUSSELL BARBOUR, Spectrum Lab, MIKHAIL GLAZOV, Ioffe Institute, KAI-MEI FU, University of Washington — We observe an anomalous B-field dependence of the spin-flip time \((T_1)\) of electrons bound to shallow donors which cannot be explained by current spin-relaxation theories. We conduct resonant pump-probe measurements in high-purity InP from the low to high magnetic field regimes, with a maximum \(T_1\) \((400 \, \mu s)\) observed near the turning point \(g\mu_B B \simeq k_B T\). At low \(B\), the \(T_1\) dependence on \(B\) is consistent with an electron correlation time \((\tau_c)\) in the tens of nanoseconds. The physical mechanism for the short \(\tau_c\) in this high-purity sample \((n \simeq 2 \times 10^{14} \, \text{cm}^{-3})\) is unclear, but a strong temperature \((T)\) dependence indicates \(T_1\) can be further increased by lowering \(T\) below the 1.5 K experimental temperature. At high \(B\), a \(B^{-5}\) dependence is observed, in contrast to the expected \(B^{-5}\) predicted by single-phonon spin-orbit mediated interactions. An understanding of the anomalous \(B\)-field dependence is expected to elucidate the effect of electron transport (low-field) and phonons (high-field) on \(T_1\) for shallow donors, which is of interest for both ensemble and single-spin quantum information applications.

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